FOREST PEST MANAGEMENT
Pacific Southwest Region

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Evaluation of Dwarf Mistletoe in the Teton Timber Sale, Clark Fork Area, Summit Ranger District, Stanislaus National Forest

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BACKGROUND

The Summit Ranger District is planning to treat forested stands in units along and north of the Clark Fork of the Stanislaus River as part of the Teton Timber Sale. Because of currently existing heavy fuel loads, it may be necessary to mechanically remove some of the fuels prior to prescribed burning. The area is subject to management direction under the California Spotted Owl (CASPO) Interim Guidelines and designation as a Wild and Scenic River. Wild and Scenic River restrictions apply to areas one-quarter mile on either side of the river.

The timber stands, at approximately 6300 feet elevation, are classified mixed conifer (R5 Site Classes 3 and 4) and have overstories of Jeffrey pine, white fir and incense-cedar. There are a few scattered predominant Jeffrey pine and incense cedar over 40 inches DBH. Some areas have a California black oak component, while sugar pine is rare. Natural understories are primarily white fir and incense-cedar. Two plantations (17 and 7 acres) stocked entirely with Jeffrey pine are present in the area. Many locations within these units are overstocked relative to site quality, and basal areas in excess of 300 square feet per acre have been measured. Our primary objectives for this site visit were to evaluate the dwarf mistletoe affecting Jeffrey pine and determine whether there are opportunities during entry to reduce its effect on the stands.

OBSERVATIONS

Moderate to severe infections of western dwarf mistletoe (*Arceuthobium campylopodum*) are present on Jeffrey pine throughout much of the area (refer to Pest Biologies at the end of this

report.) Trees of all sizes are affected and the multistoried structure present creates conditions ideal for the spread of dwarf mistletoe. We examined a 7-acre Jeffery pine plantation, established in 1954, that has never been thinned. Height and diameter growth are still acceptable for the plantation trees, but inter-tree competition will eventually begin to take its toll. Dwarf mistletoe has already moved into the plantation from adjacent infected overstory Jeffrey pines and is adding one more stress to trees. Not all plantation trees are currently infected, but others have Hawksworth dwarf mistletoe ratings as high as 4.

In the mature stands, we observed no recently killed trees, but pockets of dense down woody material are present within the units as are scattered old snags. The older mortality, both standing and down, most likely dates back to drought conditions that existed in the late 1980's to early 1990's. Galleries of the Jeffrey pine beetle (*Dendroctonus jeffreyi*) and fir engraver beetle (*Scolytus ventralis*) were present on down pine and white fir logs, respectively.

DISCUSSION/CONCLUSIONS

Dwarf Mistletoe/Bark Beetles

Bark and engraver beetle activity can be expected to recur periodically as the stands are stressed by overstocking, increasing dwarf mistletoe infections and intermittent drought. Many stands within the Teton Timber Sale area, therefore, would benefit from thinning to 1) reduce fuels, 2) lower stocking and prevent future bark beetle mortality, and 3) reduce dwarf mistletoe effects by selectively removing infected trees. Reducing stand densities to more desirable basal areas will enhance tree vigor and minimize the risk of future bark beetle attacks. Any thinning guides in the natural stands should incorporate dwarf mistletoe ratings to discriminate against the most severely infected pines (generally those with Hawksworth ratings of 4 or more).

In particular, the 7-acre plantation is overstocked and being invaded by dwarf mistletoe. Marking guides based on spacing, crown position and dwarf mistletoe infection rating would produce a stand with much improved tree health. Either of the two guides below can be used to select which trees to retain relative to dwarf mistletoe.

Method 1:

Crop Tree DBH (inches)	**Max. DM Rating Tolerated** (Using Hawksworth System)
1 – 2	0
3 – 4	1
5 – 6	2
7+	3

Method 2:

1. Trees less than 2" DBH:	**No infections**
2. Trees more than 2" DBH:	(Follow the order below to select crop trees) 1-Dom and co-dom trees with **no infections** 2-Dom and co-dom trees, DM only in lower 1/3 crown 3-Dom and co-dom trees, DM only in lower 1/2 crown and less than 50% of branches infected 4-Intermediate trees with **no infections**

It is not necessary to eliminate all dwarf mistletoe in a stand. If residual pines can growth at least 12 inches in height each year, they will normally outgrow the mistletoe. Pines with dwarf mistletoe plants in less than one-half of their crown can usually continue to grow reasonably well in height and basal area. Pruning the lower crowns of infected trees offers the opportunity to further reduce the impact of mistletoe, and would allow leaving some trees with moderate mistletoe rating during thinning. When pruning, never remove more than 50% of the existing live crown, and the live crown ratio of trees, after pruning, should not be less than 40%.

The treatments above assume that there is no overstory source of dwarf mistletoe seed in or adjacent to the stand. Adjacent infected overstory trees can be removed or just killed and left for snags. Dwarf mistletoe does not survive in dead trees. If infected overstory trees are of high value and cannot be removed or killed they can be left untreated in the stand. However, any Jeffrey pine understory or regeneration will eventually be infected and/or re-infected over time. These trees will most likely never reach commercial size.

White Pine Blister Rust

We found only 2 sugar pines during our site visit and one of them had lethal infections of white pine blister rust (*Cronartium ribicola*). Forest sites near rivers and streams are often high risk for blister rust. I would encourage the District to plant rust resistant sugar pine if all of the following conditions are met:

1. Sugar pine is desired on the site.
2. The site is silviculturally suitable to support sugar pine.
3. Openings large enough to allow establishment and survival of pines are created.
4. Rust resistant sugar pine is available for this elevation/seed zone.
5. Competing vegetation can be controlled.

Elytroderma Needle Disease

The Clark Fork area has a history of moderate to severe infestations of Elytroderma needle disease, caused by the fungus *Elytroderma deformans*. Chronic infections have probably existed here for many years and will always be present. Reports of conspicuous needle mortality are common in the spring. The environmental conditions along the Clark Fork are apparently very conducive to perpetuating this pathogen.

Elytroderma deformans persists in the twigs of infected trees and gradually reduces the amount of live crown supporting tree growth. When more than half of a tree's crown is affected by this needle disease, the tree is subject to successful bark beetle attack and should be considered for removal. It takes many years for this fungus to build up to damaging levels, but unfortunately, many Jeffrey pines in the area have already reached this condition. Control actions are not usually initiated solely because of *E. deformans*, but when stands are entered for other reasons, this disease can be targeted for treatment.

The symptoms of Elytroderma needle disease are most apparent during the spring and early summer when the previous year's foliage is dying or dead and the new needle growth is a healthy green. We conducted this site visit at a time of year when the symptoms of needle disease are least noticeable. The District should try to do any marking for thinning during the early part of the growing season to make detection of Elytroderma easier.

PEST BIOLOGIES

Dwarf Mistletoes

Dwarf mistletoes (*Arceuthobium* spp.) are parasitic, flowering plants that can only survive on living conifers in the family Pinaceae. Each species of dwarf mistletoe infects one or a few closely related species of trees. They obtain most of their nutrients and all of their water and minerals from their conifer hosts.

Dwarf mistletoes have a unique method of seed dispersal. Seeds are forcibly discharged in the fall when the fruit ripen and are shot out for many feet. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them

as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occassionally vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of Digger pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow- green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached, and abscised plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

White Pine Blister Rust

Blister rust (*Cronartium ribicola*) is caused by an obligate parasite that attacks sugar and western white pines and several species of *Ribes*. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on *Ribes*. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to *Ribes* where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves re-infect other *Ribes* throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on *Ribes* leaves in the fall. Teliospores germinate in place to produce spores (sporida) which are wind-disseminated to pines and infect current year needles. Following infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to *Ribes* to continue the cycle. Although blister rust may spread hundreds of miles from pines to *Ribes*, its spread from *Ribes* back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers (these are called **lethal** cankers). Bole cankers result in girdling and death of the tree above the canker. Cankers whose closest margins are more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result (these are called **non-lethal** cankers).

Environmental conditions are critical for successful infection and limit the disease in most years. Moisture and low temperatures favor infection of both hosts, and must coincide with spore dispersal for infection to occur. In California, these conditions occur only infrequently, usually in cool moist sites such as stream bottoms or around meadows. In so called "wave years" when

favorable conditions occur, high levels of infection can result. Wave years in California have occurred at approximately ten-year intervals in the past. As one moves from sites most favorable for rust to less favorable sites, the frequency of wave years decreases.

Elytroderma Needle Disease

The fungus *Elytroderma deformans* causes the most serious needle disease of ponderosa and Jeffrey pines in California. Occasional hosts include lodgepole, knobcone, Coulter, and pinyon pines. Unlike other needle diseases, Elytroderma infects twigs and branches systemically, allowing continued reinfection of a host's new needles even under adverse environmental conditions. Elytroderma impact is most severe in recreation forests, where the unsightly appearance of infected trees and occasional mortality can degrade the visual quality and health of a stand.

Fungal fruiting bodies (hysterothecia) release spores from infected needles in late summer and early fall. Spores are windborne to susceptible hosts and, if environmental conditions are suitable, they germinate and infect the current year's needles. Initially, the fungus grows through the needle and into the twig without killing the needle. The following spring, infected needles die and turn a conspicuous red-brown. Infected branches take on a characteristic appearance, with current year's needles looking green and healthy while the one-year-old, infected needles are bright red-brown. Long, narrow, dull black fruiting bodies form on all surfaces of the dead needles and mature later in the summer, completing the infection cycle.

Fungal mycelium within the twigs spreads into the growing tips and buds, deforming future branch growth. As a result, infected branches have a broomed appearance similar to that caused by dwarf mistletoes. However, Elytroderma brooms are distinguished by several characteristics: the red-brown color of one-year-old needles in spring and early summer; fruiting bodies scattered over the needle surface; resinous, brown necrotic lesions in the inner bark of twigs and branches infected for three years or more; and, a lack of mistletoe shoots or basal cups.

Elytroderma disease kills one-year-old needles prematurely and deforms infected twigs and branches. Generally, pines are little affected if fewer than 40 percent of the twigs are infected. The disease seldom kills mature trees directly, but moderate-to-severe infection can predispose them to bark beetle attack. The disease is most severe on seedlings, saplings, and poles that are suppressed or have thin crowns. Disease outbreaks are uncommon, but once started, the disease can persist for many years, particularly on moist sites.